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Hawkins,
C. P.

LIVESTOCK GRAZING IMPACTS ON RIPARIAN
& AQUATIC ECOSYSTEMS IN THE WILDERNESS
OF THE WESTERN U.S.:SYSTHESIS OF EXISTNG
KNOWLEDGE & RECOMMENDATIONS FOR
RESEARCH Dr. Charles Hawkins

Final Report

FINAL REPORT FOR RESEARCH AGREEMENT
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"Livestock Grazing Impacts on Riparian and Aquatic
Ecosystems in Wildernesses of the Western United..."
UTAH STATE UNIVERSITY
FS Contact: Dr. Peter Landres
CoOp Contact: Dr. Charles Hawkins

Livestock grazing impacts on riparian and aquatic ecosystems in the
wilderness of the western United States: synthesis of existing knowledge
and recommendations for research.

Research Joint Venture Agreement INT-94970-RJVA

between

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and
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Dr. Peter Landres
Aldo Leopold Wilderness Institute
USDA, Forest Service
Box 8089
Missoula, Montana 59807

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By

Charles P. Hawkins
Department of Fisheries and Wildlife
Utah State University
Logan, UT 84322-5210

Introduction and Statement of the Problem

Livestock grazing is known to have severely degraded some stream and riparian ecosystems (Platts 1979, Skovlin 1984, Kaufmann and Krueger 1984, Armour et al. 1994, Fleischner 1994) and thus is an important concern for those responsible for the management of those wilderness areas where livestock grazing is permitted. However, development and implementation of specific management plans has been difficult for two reasons: (1) a lack of information on the effects of livestock grazing on streams and riparian ecosystems specific to wilderness areas and (2) our inability to date to derive empirical generalizations based on quantitative and replicated data regarding the effects of livestock on these ecosystems either within or outside wilderness areas. The objectives of this project were to:

1. Synthesize the literature on livestock grazing impacts to riparian and aquatic ecosystems in wilderness of the western United States.
2. Analyze the data from as many prior studies as feasible in a meta-analysis to discern broad geographic and ecological patterns in livestock grazing impacts to riparian and aquatic ecosystems of the western United States.
3. Develop a set of prioritized knowledge-gaps based upon the literature synthesis and meta-analysis.
4. Prioritize recommendations for future research on livestock grazing impacts to riparian and aquatic ecosystems of the western United States based on the literature synthesis, meta-analysis, and the set of prioritized knowledge gaps.

Methods

Literature Search — We compiled literature regarding the effects of livestock grazing on stream and riparian ecosystems by searching a series of computerized databases:

1. MERLIN (Utah State University's main library facility),
2. Several CD ROM data bases including:
 - Fish and Wildlife Worldwide
 - Natural Resources
 - Wildlife Worldwide
 - AGRICOLA (a comprehensive database covering all aspects of agriculture and forestry),
 - Water Resources Abstracts, and
 - Index to Government Documents
3. BIOSIS (a data base containing over 8.5 million citations from Biological Abstracts and BioResearch), and
4. CAB (Commonwealth Agricultural Bureaux), a database containing citations from over 8,500 journals.

Sources identified from these searches were classified into 13 categories depending on the primary focus of the paper.

Vegetation studies that examined effects of grazing on riparian vegetation. Response variables included vegetation density, cover, biomass, height, production, diversity, or reproductive success.

Wildlife literature summarized intensity of use of riparian areas by wildlife in the presence and absence of grazing. Taxa examined included deer, elk, small mammals, reptiles, and amphibians.

Bird studies that examined response of birds to grazing.

Geomorphology literature that reported how bank stability, channel morphology, riffle/pool ratio, or substrate character varied between grazed and ungrazed streams.

Soil studies that examined grazing effects on soil compaction, moisture content, or chemistry.

Water Quality reports that typically examined how grazing affected nutrient concentrations, bacteria populations, turbidity, or suspended solids.

Hydrology studies that described grazing effects on stream flow, timing, or water yield.

Fish studies that included evaluations of fish biomass, density, community composition, production, or changes in habitat.

Aquatic Invertebrate studies that examined how invertebrate assemblages responded to livestock grazing.

Livestock studies that examined cattle or sheep nutrition or behavior as a function of habitat use.

Wilderness Issues that describe proposed techniques for evaluating effects of grazing on wilderness areas or evaluate effects of grazing on wilderness values.

General Information or Policy Documents that included descriptions of management practices, literature reviews, or qualitative summaries or reviews of the effects of grazing on riparian areas.

Other studies dealing with miscellaneous aspects of livestock grazing and riparian areas.

Meta-analysis — To conduct a meta-analysis, we needed to compile data from those studies that contained quantitative data into a single data file. Such a file will typically contain information on the initial design, the response variables and any covariates measured, and response variables standardized in such a way to allow direct comparisons among studies. For each of the reports examined, we extracted data on response variables from grazed and ungrazed treatments. Other treatments were sometimes included in study designs but were too infrequently used for inclusion in this review. It was also clear that the meaning of an ungrazed treatment varied from study to study. In some cases, the ungrazed treatment may have been close to having never been exposed to significant livestock grazing. In other cases, the ungrazed treatment was an area in which livestock had been excluded for several to many years. We could not examine the potentially confounding effect of length of time “ungrazed” treatments had been livestock free, and this fact represents a potentially serious limitation in our ability to generalize from the data we examined.

In addition to the meta-analysis we also conducted vote counting analyses to determine to the frequency of studies in which livestock grazing had significant effects on response variables. In this analysis, we used 3 measures of significance following Feminella and Hawkins (1995). First we tallied the number of studies in which the authors reported differences between grazed and ungrazed treatments to be statistically significant ($P < 0.05$). Second, we calculated the difference between treatments and assumed differences $> 1.5X$ to be ecologically significant. Third, we tallied the number of studies in which trends (the direction of response) between treatments either agreed or disagreed with expectations based on our understanding of conventional wisdom.

Results

Of the thousands of articles searched, we found 245 sources that contained relevant information potentially useful to our study (Appendix A). The focus of these studies varied considerably and were not uniformly distributed among the categories we examined (Fig. 1). The most frequently encountered type of study was that dealing with general riparian management or policy issues. The most frequently encountered studies that contained quantitative data were those examining responses of riparian vegetation, wildlife, birds, and stream geomorphology to livestock grazing. Fewer papers contained data that dealt with soils, hydrology, water quality, fish and aquatic invertebrates. Several papers contained data describing livestock nutritional and behavioral responses, whereas very few dealt with wilderness issues.

Of the reports we examined only 25 studies contained quantitative data of sufficient rigor for use in a meta-analysis (Appendix B). Because some studies examined more than 1 response variable, these 25 studies reported 98 different contrasts in response variables between grazed and ungrazed treatments (Fig. 2). Although sample sizes were generally high enough within some categories to allow a meta-analysis, the

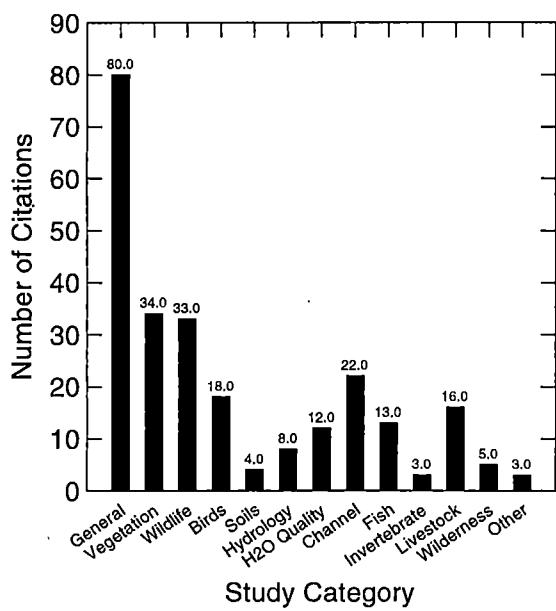


Fig. 1. Number of studies dealing with different aspects of livestock grazing and riparian ecosystems. Some papers contained data on more than one type of response variable.

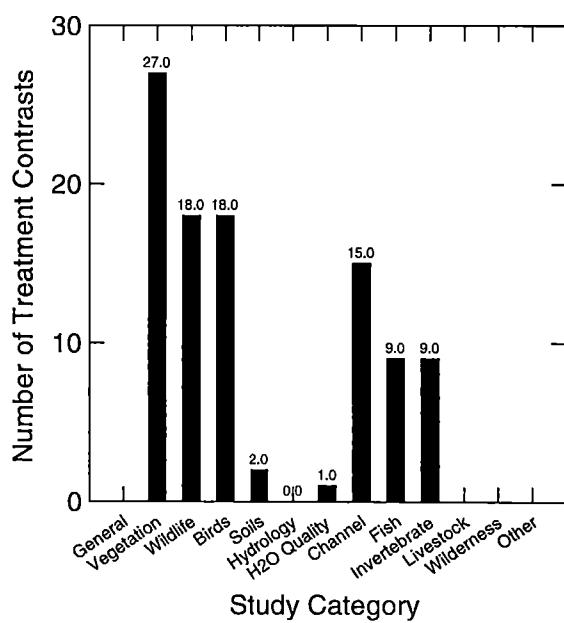


Fig. 2. Number of treatment contrasts (grazed versus nongrazed) extracted from sources in Fig. 1.

specific measures used within each category of response variable varied markedly (Table 1). We therefore concluded that inferences derived from such an analysis, even after data standardization, would be of doubtful use and likely misleading.

General Patterns

Few clear trends emerged from the compiled data with respect to magnitude of response to grazing or direction of trends (Appendix B). Only 10 of the contrasts included tests of statistical significance of the results and of those that did, 4 reported significant ($P < 0.05$) differences between grazed and ungrazed treatments and 6 contrasts were not significantly different. Many of the differences between treatments were potentially too small to be detected by typical statistical tests had they been applied with 61% of contrasts reporting less than a 1.5 fold difference between grazed and ungrazed treatments. Furthermore, in only 59% of the contrasts were trends (direction of response to grazing) consistent with expectations based on our general understanding of how livestock should affect stream and riparian ecosystems.

Table 1. Measures used in reporting results of studies for each response variable.

Response Category	Variables Measured	Number of Contrasts	Response Category	Variables Measured	Number of Contrasts
Vegetation	Density (4 measures)	11	Soils	% Organic Matter	1
	Volume	4		Phosphorus	1
	Diversity (H')	5			
	Richness	5			
Wildlife	Density	3	Water Quality	21 Variables	1
	Catch per effort	3			
	Numbers	1			
	H'	5			
	Richness	6			
Birds	Density (2 measures)	4	Fish	Biomass (3 measures)	5
	Number	2		Density (2 measures)	1
	H'	6		Relative Density	
	Richness	6			
Channel	Pool Abundance	1	Aquatic Invertebrates	Biomass	1
	% Riffle	1		Density	2
	Pool Volume	3		H'	2
	Width/Depth	6		Richness	2
	% Fine Sediment	4		Biotic Condition Index	1

Table 2. Number of contrasts with difference between treatments > 1.5 X or not and number of contrasts agreeing or disagreeing with expected trends.

> 1.5X?	Vegetation	Wildlife	Birds	Channel
Y	13	7	6	3
N	14	11	12	12
	Soil	Water Qual.	Fish	Aquatic Invert.
Y	2	0	6	2
N	0	1	3	7
Expected Trend?	Vegetation	Wildlife	Birds	Channel
Y	16	14	6	9
N	11	3	12	6
	Soil	Water Qual.	Fish	Aquatic Invert.
Y	2	ND	7	4
N	0	ND	2	5

Although sample sizes within any single category of response variable were too small to draw definitive conclusions, some categories appeared to respond more strongly to grazing than others (Table 2). Also, overall responses of some categories tended to agree with expectations whereas responses for other categories tended to be inconsistent with expectations (Table 2). Few bird, aquatic invertebrate, and channel contrasts showed differences of 1.5-fold or greater, whereas 67% of fish measures did. The general trend within bird studies was for responses to be opposite that expected, i.e., richness or abundance often was higher in the grazed treatment. In contrast, the trend within channel and wildlife studies generally agreed with expectations: e.g., channel width-depth ratios were higher in grazed areas and wildlife richness or abundance was usually lower in grazed areas.

Discussion

Objective 1. Synthesize the literature on livestock grazing impacts to riparian and aquatic ecosystems in wilderness of the western United States.

It was apparent from this study that we cannot yet generalize with confidence about the effects livestock grazing have on riparian ecosystems as a whole. The extant literature provides glimpses of how a variety of different variables measured in different ways respond to grazing under different environmental settings, but the lack of truly replicated studies or studies comparing similar treatments over a range of settings prohibits drawing even qualitative inferences in most cases. As a consequence our understanding of, and hence ability to predict, the effects livestock grazing will have on riparian ecosystems in wilderness areas is extremely limited.

Objective 2. Analyze the data from as many prior studies as feasible in a meta-analysis to discern broad geographic and ecological patterns in livestock grazing impacts to riparian and aquatic ecosystems of the western United States.

Although natural resource managers have been interested in the effects of livestock grazing on riparian ecosystems for over 3 decades and thousands of papers and reports have been published on this issue, quantitative data from well designed studies are sorely lacking. This lack of quantitative data measured in standard ways precluded conducting meta-analyses, which have been so useful in other areas of science in increasing our overall understanding of interactions and processes that individual studies can seldom elucidate.

Objective 3. Develop a set of prioritized knowledge-gaps based upon the literature synthesis and meta-analysis.

The majority of studies on effects of livestock grazing have focused on wildlife (36 contrasts including birds) and vegetation (27 contrasts) responses. These relatively sample sizes notwithstanding, clear generalizations did not emerge from the literature we examined suggesting that responses may be somewhat specific to different types of

environmental settings. We could not evaluate this hypothesis however, because too little information was provided in most reports for us to examine how responses varied to livestock grazing under different climatic, geologic, and ecological conditions. We strongly suspect that such studies will be required before any clarity emerges, however a coordinated effort with a considerable investment in time and resources will almost certainly be needed on the part of natural resource management agencies to address the current inadequate state of our knowledge.

Objective 4. Prioritize recommendations for future research on livestock grazing impacts to riparian and aquatic ecosystems of the western United States based on the literature synthesis, meta-analysis, and the set of prioritized knowledge gaps.

The availability of quantitative data from which we might predict how specific riparian ecosystems will respond to livestock grazing is so meager that it is premature to prioritize research needs. Rankings would almost certainly differ depending on region and specific management challenges. Considering the values that we manage for in wilderness areas, it seems clear however that studies that focus on effects of livestock on both the aesthetic nature of riparian ecosystems and their ability to support high biodiversity and water quality are critically needed. Considering that these 2 broad areas encompass most of the categories of variables reviewed here, it seems a prudent research strategy to adopt in both wilderness and non-wilderness areas would be to design standardized, synoptic, and holistic studies that could be conducted in several settings thus providing both sorely needed replication as well as data on overall ecosystem responses. Such a research effort would have significant initial costs, but the long-term cost of such an approach would be modest in terms of the information gained and hence our ability to devise more objective management plans for livestock in riparian areas.

Literature Cited

- Armour, C., D. Duff, and W. Elmore. 1994. The effects of livestock grazing on western riparian and stream ecosystem. *Fisheries* 19(9):9-12.
- Feminella, J.W. and C. P. Hawkins. 1995. Interactions between stream herbivores and periphyton: a quantitative analysis of past experiments. *Journal of the North American Benthological Society* 14:465-509.
- Fleischner, T. L. 1994. Ecological costs of livestock grazing in western North America. *Conservation Biology* 8:629-644.
- Kauffman, J. B., and W. C. Krueger. 1984. Livestock impacts on riparian ecosystems and streamside management implications... A review. *Journal of Range Management* 37:430-436.

- Platts, W. S. 1979. Livestock grazing and riparian/stream ecosystems - an overview. Pages 39-45 *in* O. B. Cope, editor. Proceedings, Forum - grazing and riparian/stream ecosystems. Trout Unlimited, Inc., Vienna, Virginia.
- Skovlin, J. M. 1984. Impacts of grazing on wetlands and riparian habitat: A review of our knowledge. Pages 1001-1103 *in* N. A. of S. National Research Council, editor. Developing strategies for rangeland management. Westview Press, Boulder.

Appendix A

Reference Number	Citation
13434.	Abdel-Magid, A. H., G. E. Schuman, and R. H. Hart. 1987a. Soil bulk density and water infiltration as affected by grazing systems. <i>Journal of Range Management</i> 40:307-309.
13433.	Abdel-Magid, A. H., M. J. Trlica, and R. H. Hart. 1987b. Soil and vegetation responses to simulated trampling. <i>Journal of Range Management</i> 40:303-306.
12847.	Abramchuck, A. V., and P. L. Gorchakowskii. 1980. Formation and anthropogenic degradation of meadow plant communities in the Trans-Ural Forest-Steppe region. <i>Ekologiya</i> 1:22-34.
6465.	Agee, J. 1979. Controlling water pollution from grazing activities. Pages 15-17 <i>in</i> O. B. Cope, editor. <i>Proceedings of the Forum - Grazing and riparian/stream ecosystems at Denver, CO, Nov. 3-4, 1978.</i> Trout Unlimited, Inc., Vienna, Virginia.
13436.	Allison, C. D. 1985. Factors affecting forage intake by range ruminants: A review. <i>Journal of Range Management</i> 38:305-311.
13103.	Ames, C. R. 1977. Wildlife conflicts in riparian management: Grazing. Pages 49-51 <i>in</i> Importance, preservation and management of riparian habitat: A symposium. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Gen Tech Rep No. RM-43.
6450.	Anderson, A., G. Haugen, D. Duff, G. Taylor, D. Albin, D. Erman, D. Reiser, M. Bacon, T. Jackson, K. Overton, C. McAucliff, J. Griffith, and J. Cooper. 1982. The best management practices for the management and protection of western riparian stream ecosystems. American Fisheries Society, Western Division, Betheseda, MA.
13439.	Anderson, J. E., and K. E. Holte. 1981. Vegetation development over 25 years without grazing on sagebrush-dominated rangeland in southeastern Idaho. <i>Journal of Range Management</i> 34:25-29.
12849.	Anderson, L. M. 1981. Land use designations affect perception of scenic beauty in forest landscapes. <i>Forest Science</i> 27:392-400.
12595.	Armour, C., D. Duff, and W. Elmore. 1994. The effects of livestock grazing on western riparian and stream ecosystem. <i>Fisheries</i> 19(9):9-12.

13438. Austin, D. D., P. J. Urness, and R. A. Riggs. 1986. Vegetal change in the absence of livestock grazing, Mountain Brush Zone, Utah. *Journal of Range Management* 39:514-517.
13462. Bedell, T. E. 1993a. Introduction and philosophy. Pages 1-3 *in* Watershed management guide for the interior Northwest. Oregon State University Extension Service, Corvallis.
13463. ---. 1993b. Managing riparian areas. Pages 5 *in* Watershed management guide for the interior Northwest. Oregon State University Extension Service, Corvallis.
13468. Bedell, T. E., and J. Buckhouse. 1993. Managing rangelands. Pages 9-38 *in* Watershed management guide for the interior Northwest. Oregon State University Extension Service, Corvallis.
13552. Beebe, J. D., and G. R. Hoffman. 1968. Effects of grazing on vegetation and soils in southeastern South Dakota. *American Midland Naturalist* 80:96-110.
13474. Behnke, R. J. 1977. Fish faunal changes associated with land-use and water development. *Great Plains-Rocky Mountain Geology Journal* 6:133-136.
13457. ---. 1978. Grazing and the riparian zone: impact on aquatic values. Pages 126-131 *in* W. D. Graul and S. J. Bissell, editors. Lowland River and stream habitat in Colorado: A symposium (Greeley, CO, Oct. 4-5, 1978). Colo. Chap. Wildl. Soc. & Colo. Audubon Council, Greeley, CO.
13707. Behnke, R. J., and R. F. Raleigh. 1978. Grazing and the riparian zone: impact and management perspective. Pages 263-267 *in* R. R. Johnson and J. F. McCormick, editors. Strategies for protection and management of floodplain wetlands and other riparian ecosystems. Proc. symp. Dec. 11-13, 1978, Callaway Gardens, GA. U. S. Department of Agriculture, Forest Service, Washington, D.C., Gen. Tech. Rep. WO-12.
13708. Best, L. B., D. F. Stauffer, and A. R. Geier. 1978. Evaluating the effects of habitat alteration on birds and small mammals occupying riparian communities. Pages 117-124 *in* R. R. Johnson and J. F. McCormick, editors. Strategies for protection and management of floodplain wetlands and other riparian ecosystems. Proc. symp. Dec. 11-13, 1978, Callaway Gardens, GA. U. S. Department of Agriculture, Forest Service, Washington, D.C., Gen. Tech. Rep. WO-12.
12850. Bezanson, C. E., and L. E. Hughes. 1989. A riparian zone - One story.

Rangelands 11:56-57.

13427. Blackburn, W. H. 1983. Livestock grazing impacts on watersheds. Rangelands 5:123-125.
13102. ---. 1984. Impacts of grazing intensity and specialized grazing systems on watershed characteristics and responses. Pages 927-983 *in* N. A. of S. National Research Council, editor. Developing strategies for rangeland management. Westview Press, Boulder.
12851. Blackburn, W. H., R. W. Knight, and M. K. Wood. 1982. Impacts of grazing on watersheds, a state of knowledge. Pages 1-32 *in* Impacts of grazing intensity and specialized grazing systems on use and value of rangelands. National Academy of Sciences/ National Research Council Workshop, El Paso, Texas. Texas Agricultural Experiment Station, Texas A & M University, College Station, TX.
13440. Blydenstein, J., C. R. Hungerford, G. I. Day, and R. R. Humphrey. 1957. Effect of domestic livestock exclusion on vegetation in the Sonoran Desert. Ecology 38:522-526.
8948. Bohn, C. 1989. Management of winter soil temperatures to control streambank erosion. Pages 69-71 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.
13437. Bohn, C. C., and J. C. Buckhouse. 1985. Some responses of riparian soils to grazing management in northeastern Oregon. Journal of Range Management 38:378-381.
13435. Bonham, C. D. 1972. Vegetation analysis of grazed and ungrazed alpine hairgrass meadows. Journal of Range Management 25:276-279.
13088. Bottorff, R. L. 1974. Cottonwood habitat for birds in Colorado. American Birds 28:975-979.
13085. Bowers, W., B. Hosford, A. Oakley, and C. Bond. 1979. Wildlife habitats in managed rangelands -- The Great Basin of southeastern Oregon : Native trout, 1st Edition. USDA, Forest Service, Pacific Northwest Forest and Range Experiment Station, Corvallis, Gen. Tech. Rep. No. PNW-84.
13444. Box, T. W. 1967. Influence of drought and grazing on mortality of five west Texas grasses. Ecology 48:654-656.

13445. Boyer, W. D. 1967. Grazing hampers development of longleaf pine seedlings in Southwest Alabama. *Journal of Forestry* 65:336-338.
13446. Bransby, D. I., B. E. Conrad, H. M. Dicks, and J. W. Drane. 1988. Justification for grazing intensity experiments: Analysising and interpreting grazing data. *Journal of Range Management* 41:274-279.
13115. Branson, F. A. 1984. Evaluation of "Impacts of grazing intensity and specialized grazing systems on watershed characteristics and responses". Pages 985-1000 in N. A. of S. National Research Council, editor. *Developing strategies for rangeland management*. Westview Press, Boulder.
13443. Brooker, M. P. 1985. The impact of river channelization - IV the ecological effects of channelization. *Geographical Journal* 151:63-69.
13452. Bryant, L. D. 1979. Livestock response to riparian zone exclusion. Master of Science Thesis. University of Idaho, Moscow.
12852. ---. 1982. Response of livestock to riparian zone exclusion. *Journal of Range Management* 35:780-785.
13062. ---. 1984. Livestock management in the riparian ecosystem. Pages 285-289 in *Riparian ecosystems and their management: Reconciling conflicting uses*, 1st Edition. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins.
13421. Bryant, L. D., and J. M. Skovlin. 1981. Effect of grazing strategies and rehabilitation on an eastern Oregon stream. Pages 27-30 in K. A. Hashagan, editor. *Habitat disturbance and recovery*. California Trout, Inc., San Francisco.
13467. Buckhouse, J. 1993. Managing upland watershed in grazed semiarid rangelands. Pages 7-8 in *Watershed management guide for the interior Northwest*. Oregon State University Extension Service, Corvallis.
13470. Buckhouse, J., and W. Elmore. 1993. Grazing practice relationships: Predicting riparian vegetation response from stream systems. Pages 47-52 in *Watershed management guide for the interior Northwest*. Oregon State University Extension Service, Corvallis.
13100. Buckhouse, J. C., and G. F. Gifford. 1976. Water quality implications of cattle grazing on a semiarid watershed in southeastern Utah. *Journal of Range Management* 29:109-113.

13553. Buckhouse, J. C., R. W. Knight, and J. M. Skovlin. 1979. Some erosional and water quality responses to selected animal grazing practices in northeastern Oregon. Pages 13-22 *in* Proceedings of the Oregon Association Academy of Science. Volume 15. Oregon State University, Corvallis. (Proceedings of the Oregon Association of Science; 15; 13-22)
9662. Burton, T., N. Bare, G. Ketcheson, H. Hudak, W. Little, W. Grow, T. M. Collins, A. H. Winward, D. Duff, and H. Forsgren. 1992. Integrated riparian evaluation guide: Intermountain Region March 1992, 1st Edition. USDA, Forest Service, Intermountain Region, Ogden, UT.
6463. Busby, F. E. 1979. Riparian and stream ecosystems, livestock grazing, and multiple-use management. Pages 6-12 *in* O. B. Cope, editor. Proceedings of the Forum - Grazing and riparian/stream ecosystems at Denver, CO, Nov. 3-4, 1978. Trout Unlimited, Inc., Vienna, Virginia.
13431. Buttery, R. F., and P. W. Shields. 1975. Range management practices and bird habitat values. Pages 183-189 *in* D. R. Smith, editor. Proceedings of the symposium on management of forest and range habitats for nongame birds. USDA, Forest Service, Washington, D.C.
13118. Cagney, J. 1993. Riparian Area Management: Greenline riparian-wetland monitoring, 1st Edition. U.S. Department of Interior, Bureau of Land Management, Denver, TR 1737-8 1993.
13106. Carpenter, L. H. 1984. Impacts of grazing intensity and specialized grazing systems on faunal composition and productivity: A discussant paper. Pages 1119-1128 *in* N. A. of S. National Research Council, editor. Developing strategies for rangeland management. Westview Press, Boulder.
13101. Carson, R. G., and J. M. Peek. 1987. Mule deer habitat selection patterns in northcentral Washington. Journal of Wildlife Management 51:46-51.
8950. Chadde, S. W., R. D. Pfister, and P. L. Hansen. 1989. Management implications for riparian dominance types of Montana. Pages 83-85 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.
6451. Chaney, E., W. Elmore, and W. S. Platts. 1990. Livestock grazing on western riparian areas. Northwest Resource Info. Center, Inc., EPA, Eagle, ID.

802. Chapman, D. W., and E. Knudsen. 1980. Channelization and livestock impacts on salmonid habitat and biomass in western Washington. *Transactions of the American Fisheries Society* 109:357-363.
13668. Chichester, F. W., R. W. Van Keuren, and J. L. McGuinness. 1979. Hydrology and chemical quality of flow from small pastured watershed: II. Chemical quality. *Journal of Environmental Quality* 8:167-171.
12853. Clary, W. P., and G. D. Booth. 1993. Early season utilization of mountain meadow riparian pastures. *Journal of Range Management* 46:493-497.
13705. Clary, W. P., and D. E. Medin. 1992. Vegetation, breeding bird, and small mammal biomass in two high-elevation sagebrush riparian habitats. Pages 100-110 in W. P. Clary, E. D. McArthur, D. Bedunah and C. L. Wambolt, editors. *Proceedings-symposium on ecology and management of riparian shrub communities; 1991 May 29-31; Sun Valley, ID.* U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT, Gen. Tech. Rep. Int-289.
12969. Clary, W. P., and B. F. Webster. 1989. Managing grazing of riparian areas in the Intermountain region, 1st Edition. USDA, Forest Service, Intermountain Research Station, Ogden, Gen. Tech. Rep. No. INT-263.
12854. ---. 1990. Riparian grazing guidelines for the Intermountain Region. *Rangelands* 12:209-212.
8956. Clifton, C. 1989. Effects of vegetation and land use on channel morphology. Pages 121-129 in R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. *Practical approaches to riparian resource management - an educational workshop.* U. S. Bureau of Land Management, Billings, Montana.
12855. Cole, D. N. 1981. Vegetational changes associated with recreational use and fire suppression in the Eagle Camp Wilderness, Oregon: Some management implications. *Biological Conservation* 20:247-270.
12558. ---. 1994. *The Wilderness Threats Matrix: A framework for assessing impacts,* 1st Edition. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Res. Pap. INT-475.
13673. Compton, B. B., R. J. Mackie, and G. L. Dusek. 1988. Factors influencing distribution of white-tailed deer in riparian habitats. *Journal of Wildlife Management* 52:544-548.

6459. Cope, O. B., editor. 1979. Proceedings of the Forum - Grazing and riparian/stream ecosystems, Nov. 3-4, 1978, Denver, CO. Trout Unlimited, Inc., Vienna, Virginia.
13702. Cortner, H. J., B. Tellman, M. G. Wallace, L. DeBano, and B. Hamre. 1993. Preface. Pages vi-vii *in* B. Tellman, H. J. Cortner, M. G. Wallace, L. F. DeBano and R. H. Hamre, editors. Riparian management: common threads and shared interests. A western regional conference on river management strategies. 1993 Feb 4-6; Albuquerque, NM. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO, Gen. Tech. Rep. RM-226.
13061. Cox, J. R., and H. L. Morton. 1984. Above-ground biomass quantities and livestock production at Big Sacaton riparian areas in southeastern Arizona. Pages 305-309 *in* Riparian ecosystems and their management: Reconciling conflicting uses, 1st Edition. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins.
7664. Crispin, V., R. House, and D. Roberts. 1993. Changes in instream habitat, large woody debris, and salmon habitat after the restructuring of a coastal Oregon stream. North American Journal of Fisheries Management 13:96-102.
13667. Crouch, G. L. 1978. Effects of protection from livestock grazing on a bottomland wildlife habitat in Northeastern Colorado. Pages 118-125 *in* W. D. Graul and S. J. Bissell, editors. Lowland River and stream habitat in Colorado: A symposium. Colorado Chapter of Wildlife Society and Colorado Audubon Council, Greeley, CO.
13554. ---. 1981. Wildlife on ungrazed bottomlands on the South Platte River, Northeastern Colorado. Pages 186-197 *in* Proceedings of the wildlife-livestock relationships symposium. Forest, Wildlife, and Range Experiment Station, University of Idaho, Moscow.
6199. Crouse, M. R., and R. R. Kindschy. 1981. A method for predicting riparian vegetation potential of semiarid rangelands. Pages 110-116 *in* N. B. Armantrout, editor. Acquisition and utilization of aquatic habitat inventory information. The Western Division, American Fisheries Society, Portland, OR.
13069. Crumpacker, D. W. 1981. Regional riparian research and a multi-university approach to the special problem of livestock grazing in the Rocky Mountains and great plains. Pages 413-423 *in* A paper presented at the California riparian systems conference, U. of C., Davis, September 17-19, 1981., .

6467. Dahlem, E. A. 1979. The Mahogany Creek watershed - with and without grazing. Pages 31-34 *in* O. B. Cope, editor. Proceedings of the Forum - Grazing and riparian/stream ecosystems at Denver, CO, Nov. 3-4, 1978. Trout Unlimited, Inc., Vienna, Virginia.
13112. Darling, L. A., and G. B. Coltharp. 1973. Effects of livestock grazing on the water quality of mountain streams. Pages 1-8 *in* H. F. Mayland, editor. Water-animal relations proceedings. Water-Animal Relations Committee, Kimberly.
13555. Davis, J. W. 1981. Livestock vs. riparian habitat management - There are solutions. Pages 175-182 *in* Proceedings of the wildlife-livestock relationships symposium. Forest, Wildlife, and Range Experiment Station, University of Idaho, Moscow.
7268. Debano, L. F., and L. J. Schmidt. 1989. Interrelationship between watershed condition and health of riparian areas in Southwestern United States. Pages 45-52 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U.S. Bureau of Land Management, Billings, Montana.
13471. Deboodt, T., and P. S. Test. 1993. Watershed management tools. Pages 53-62 *in* Watershed management guide for the interior Northwest. Oregon State University Extension Service, Corvallis.
15375. Delgado, A. N., E. L. Períago, and F. Díaz-Fierros. 1997. Effectiveness of buffer strips for attenuation of ammonium and nitrate levels in runoff from pasture amended with cattle slurry or inorganic fertilser. Pages 134-139 *in* N. E. Haycock, T. P. Burt, K. W. T. Goulding and G. Pinay, editors. Buffer zones: Their processes and potential in water protection, 1st Edition. Quest Environmental, Hertfordshire, UK.
8957. Dickson, J. G. 1989. Streamside zones and wildlife in Southern U.S. forests. Pages 131-133 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.
13429. Dickson, J. G., and J. H. Williamson. 1988. Small mammals in streamside management zones in pine plantations. Pages 375-378 *in* Management of amphibians, reptiles, and small mammals in North America. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins.

8958. Dieter, C. D., and T. R. McCabe. 1989. Habitat use in Beaver along the Big Sioux River in Eastern South Dakota. Pages 135-140 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.
13454. Elmore, W. 1992. Riparian responses to grazing practices. Pages 442-457 *in* R. J. Naiman, editor. Watershed management - Balancing sustainability and environmental change. Springer-Verlag, New York.
7382. Elmore, W., and R. L. Beschta. 1987. Riparian areas: perceptions in management. *Rangelands* 9:260-265.
13425. Elmore, W., and B. Kauffman. 1994. Riparian and watershed systems: Degradation and restoration. Pages 212-231 *in* M. Vavra, W. A. Laycock and R. D. Pieper, editors. Ecological implications of livestock herbivory in the West. Society for Range Management, Denver.
12856. Everhart, M. E. 1991. The preferred grazing system. *Rangelands* 13:266-270.
13469. Fitzgerald, S. A. 1993. Forests and watershed management in eastern Oregon. Pages 39-46 *in* Watershed management guide for the interior Northwest. Oregon State University Extension Service, Corvallis.
12600. Fleischner, T. L. 1994. Ecological costs of livestock grazing in western North America. *Conservation Biology* 8:629-644.
12857. Fraser, P. M., R. J. Haynes, and P. H. Williams. 1994. Effects of pasture improvement and intensive cultivation on microbial biomass, enzyme activities, and composition and size of earthworm populations. *Biol. Fertil. Soils* 17:185-190.
3537. Gebhart, K., S. Leonard, G. Staidl, and D. Prichard. 1990. Riparian Area Management: Riparian and wetland classification review. USDI, Bureau of Land Management, Denver, CO, TR 1737-5.
13672. Geier, A. R., and L. B. Best. 1980. Habitat selection by small mammals of riparian communities: Evaluating effects of habitat alterations. *Journal of Wildlife Management* 44:16-24.
13671. Gifford, G. F., and R. H. Hawkins. 1976. Grazing systems and watershed management: A look at the record. *Journal of Soil and Water Conservation* November-December:281-283.

12858. Gillen, R. L., W. C. Krueger, and R. F. Miller. 1985. Cattle use of riparian meadows in the Blue Mountains on Northeastern Oregon. *Journal of Range Management* 38:205-209.
13794. Gjersing, F. M. 1971. A study of waterfowl production on two rest rotation grazing units in northcentral Montana. Master of Science Thesis. Montana State University, Bozeman.
12859. Godin, V. B., and R. E. Leonard. 1979. Management problems in designated wilderness areas. *Journal of Soil and Water Conservation* May-June:141-143.
8952. Goodman, T., G. B. Donart, H. E. Kiesling, J. L. Holchek, J. P. Neel, D. Manzanares, and K. E. Severson. 1989. Cattle behavior with emphasis on time and activity allocations between upland and riparian habitats. Pages 95-102 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.
13556. Green, D. M. 1991. Soil conditions along a hydrologic gradient and successional dynamics in a grazed and ungrazed montane riparian ecosystem. Ph.D. Dissertation. Oregon State University, Corvallis.
13456. Gregg, R. 1978. A method for analyzing livestock impacts on stream and riparian habitats. Pages 89-99 *in* W. D. Graul and S. J. Bissell, editors. Lowland River and stream habitat in Colorado: A symposium (Greeley, CO, Oct. 4-5, 1978). Colo. Chap. Wildl. Soc. & Colo. Audubon Council, Greeley, CO.
2378. Hall, F. C. 1985. Management practices and options. Pages 1-17 *in* J. W. Thomas and C. Maser, editors. Wildlife habitats in managed rangelands - The Great Basin of Southeastern Oregon. USDA, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, OR, Gen. Tech. Rep. RNW-189.
8938. Hancock, J. L. 1989. Selling a successful riparian management program: a public land manager's viewpoint. Pages 1-3 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.
13703. Hansen, P. 1993. Developing a successful riparian-wetland grazing management plan for the Upper Ruby River cattle and horse allotment in southwestern Montana. Pages 328-335 *in* B. Tellman, H. J. Cortner,

- M. G. Wallace, L. F. DeBano and R. H. Hamre, editors. Riparian management: common threads and shared interests. A western regional conference on river management strategies. 1993 Feb 4-6; Albuquerque, NM. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO, Gen. Tech. Rep. RM-226.
8939. Hanson, M. L. 1989. The Oregon Watershed Improvement Coalition's approach to riparian management. Pages 5-6 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.
15310. Hatfield, D., and C. Hatfield. 1995. The Trout Creek Mountain Project, Oregon. Pages 53-58 *in* F. H. Wagner, editor. Ecosystem management of natural resources in the Intermountain West. Volume 5. Utah State University, College of Natural Resources, Logan, UT.
13557. Hayes, F. A. 1978. Streambank stability and meadow condition in relation to livestock grazing in mountain meadows of central Idaho. Master of Science Thesis. University of Idaho, Moscow.
13424. Heady, H. F. 1994. Summary: Ecological implications of livestock herbivory in the West. Pages 289-297 *in* M. Vavra, W. A. Laycock and R. D. Pieper, editors. Ecological implications of livestock herbivory in the West. Society for Range Management, Denver.
13110. Heady, H. F., and R. D. Child. 1994. Riparian areas and pollution: Best management practices. Pages 453-465 *in* H. F. Heady and R. D. Child, editors. Rangeland ecology and management. Westview Press, Boulder.
12860. Hearne, J. W., and C. Howard-Williams. 1988. Modelling nitrate removal by riparian vegetation in a springfed stream: The influence of land-use practices. Ecological Modelling 42:179-198.
12968. Heede, B. H. 1977. Case study of a watershed rehabilitation project: Alkali, Creek, Colorado, 1st Edition. USDA, Forest Service, Fort Collins.
13087. Higgins, D. A., S. B. Maloney, A. R. Tiedemann, and T. M. Quigley. 1989. Storm runoff characteristics of grazed watersheds in eastern Oregon. Water Resources Bulletin 25:87-100.
12861. Hodder, R. M., and W. A. Low. 1978. Grazing distribution of free-ranging cattle at three sites in the Alice Springs district, Central

- Australia. Australian Rangeland Journal 1:95-105.
12862. Holechek, J. L., M. Vavra, and J. Skovlin. 1982. Cattle diet and daily gains on a mountain riparian meadow in northeastern Oregon. Journal of Range Management 35:745-747.
13063. Holechek, J. L., T. J. Berry, and M. Vavra. 1987. Grazing system influences on cattle performance on mountain range. Journal of Range Management 40:55-59.
13064. Hough, J. 1986. Management alternatives for increasing dry season base flow in the Miombo woodlands of southern Africa. Ambio :341-342.
13068. Hubert, W. A., R. P. Lanka, T. A. Wesche, and F. Stabler. 1984. Grazing management influences on two brook trout streams in Wyoming. Pages 290-294 *in* Riparian ecosystems and their management: Reconciling conflicting uses. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins.
13472. Jacks, C. C. 1993. Regulations governing Oregon's watershed restoration work. Pages 63-67 *in* Watershed management guide for the interior Northwest. Oregon State University Extension Service, Corvallis.
13558. Jeffery, D. E. 1963. Factors influencing elk distribution of Willow Creek summer range, Utah. Master of Science Thesis. Utah State University, Logan.
13419. Johnson, K. L. 1992. Management for water quality on rangelands through best management practices: The Idaho approach. Pages 415-441 *in* R. J. Naiman, editor. Watershed management, 1st Edition. Springer-Verlag, New York.
13559. Johnson, S. J. 1981. Impacts of domestic livestock grazing on small mammals of forest grazing allotments in southeastern Idaho. Pages 242-250 *in* Proceedings of the wildlife-livestock relationships symposium. Volume 10. Forest, Wildlife & Range Experiment Station, University of Idaho, Moscow.
12964. Johnson, S. R., H. L. Gary, and S. L. Ponce. 1978. Range cattle impacts on stream water quality in the Colorado front range, 1st Edition. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins.
13670. Kaiser, P. H., S. S. Berlinger, and L. H. Fredrickson. 1979. Response of blue-winged teal to range management on waterfowl production areas

- in Southeastern South Dakota. *Journal of Range Management* 32:295-298.
13065. Kauffman, J. B., and W. C. Krueger. 1984. Livestock impacts on riparian ecosystems and streamside management implications... A review. *Journal of Range Management* 37:430-436.
13560. Kauffman, J. B., W. C. Krueger, and M. Vavra. 1981. Impacts of a late season grazing scheme on nongame wildlife in a Wallowa Mountain riparian ecosystem. Pages 208-220 *in* Proceedings of the wildlife-livestock relationships symposium. Volume 10. Forest, Wildlife & Range Experiment Station, University of Idaho, Moscow.
13704. Kay, C. E., and S. Chadde. 1992. Reduction of willow seed production by ungulate browsing in Yellowstone National Park. Pages 92-99 *in* W. P. Clary, E. D. McArthur, D. Bedunah and C. L. Wambolt, editors. Proceedings-symposium on ecology and management of riparian shrub communities; 1991 May 29-31; Sun Valley, ID. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT, Gen. Tech. Rep. Int-289.
6469. Keller, C., L. Anderson, and P. Tappel. 1979. Fish habitat changes in Summit Creek, Idaho, after fencing the riparian area. Pages 46-52 *in* O. B. Cope, editor. *Proceedings of the Forum - Grazing and riparian/stream ecosystems at Denver, CO, Nov. 3-4, 1978*. Trout Unlimited, Inc., Vienna, Virginia.
13104. Kennedy, C. E. 1977. Wildlife conflicts in riparian management: Water. Pages 52-58 *in* Importance, preservation and management of riparian habitat: A symposium. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins.
3558. Kinch, G. 1989. Riparian area management: Grazing management in riparian areas. USDI, Bureau of Land Management, Denver, Co., TR 1737-4.
13441. Kindschy, R. R. 1978. Rangeland management practices and bird habitat values. Pages 66-69 *in* R. M. DeGraaf, editor. *Proceedings of the workshop on nongame bird habitat management in the coniferous forests of the western United States*. USDA, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland.
12577. Kinney, J. W., and W. P. Clary. 1994. A photographic utilization guide for key riparian graminoids, 1st Edition. United States Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT,

13561. Knopf, F. L., and R. W. Cannon. 1981. Structural resilience of a willow riparian community to changes in grazing practices. Pages 198-207 in Proceedings of the wildlife-livestock relationships symposium. Volume 10. Forest, Wildlife & Range Experiment Station, University of Idaho, Moscow.
13099. Knopf, F. L., J. A. Sedgwick, and R. W. Cannon. 1988. Guild structure of a riparian avifauna relative to seasonal cattle grazing. Journal of Wildlife Management 52:280-290.
13706. Kovalchik, B. L., and W. Elmore. 1992. Effects of cattle grazing systems on willow-dominated plant associations in central Oregon. Pages 111-119 in W. P. Clary, E. D. McArthur, D. Bedunah and C. L. Wambolt, editors. Proceedings-symposium on ecology and management of riparian shrub communities; 1991 May 29-31; Sun Valley, ID. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT, Gen. Tech. Rep. Int-289.
15351. Krueger, W. C. 1994. Agriculture and riparian areas. Pages 15-18 in G. A. Rasmussen and J. P. Dobrowolski, editors. Riparian resources, 1st Edition. Volume 1. Utah State University, College of Natural Resources, Logan.
6464. Lea, G. D. 1979. BLM management and policy for riparian/stream ecosystems. Pages 13-15 in O. B. Cope, editor. Proceedings of the Forum - Grazing and riparian/stream ecosystems at Denver, CO, Nov. 3-4, 1978. Trout Unlimited, Inc., Vienna, Virginia.
13086. Leege, T. A., D. J. Herman, and B. Zamora. 1981. Effects of cattle grazing on mountain meadows in Idaho. Journal of Range Management 34:324-328.
13119. Leonard, S., G. Staidl, J. Fogg, K. Gebhardt, W. Hagenbuck, and D. Prichard. 1992. Riparian Area Management: Procedures for ecological site inventory - With special reference to riparian-wetland sites, 1st Edition. U.S. Department of Interior, Bureau of Land Management, Denver, TR 1737-7 1992.
12564. Li, H. W., G. A. Lamberti, T. N. Parsons, C. K. Tait, and J. L. Li. 1994. Cumulative effects of riparian disturbances along high desert trout streams of the John Day Basin, Oregon. Transactions of the American Fisheries Society 123:627-640.

13067. Loft, E. R., J. W. Menke, and J. G. Kie. 1986. Interaction of cattle and deer on mountain rangeland. California Agriculture Jan/Feb:6-9.
13066. Loft, E. R., J. W. Menke, J. G. Kie, and R. C. Bertram. 1987. Influence of cattle stocking rate on the structural profile of deer hiding cover. Journal of Wildlife Management 51:655-664.
12966. Lusby, G. C., G. T. Turner, J. R. Thompson, and V. H. Reid. 1970. Geological survey water-supply paper: Hydrologic and biotic characteristics of grazed and un grazed watersheds of the Badger Wash Basin in Western Colorado, 1953-58 - Hydrologic effects of land use, 1st Edition. United States Government Printing Office, Washington, D.C., Paper No. 1532-B.
12965. Lusby, G. C., V. H. Reid, and O. D. Knipe. 1971. Geological survey water-supply paper: Effects of grazing on the hydrology and biology of the Badger Wash Basin in Western Colorado, 1953-66 - Hydrologic effects of land use, 1st Edition. United States Government Printing Office, Washington, D.C., Paper No. 1532-D.
15873. Magilligan, F. J., and P. F. McDowell. 1997. Stream Channel Adjustments Following Elimination of Cattle Grazing. American Water Resources Association 33:867-877.
13107. Malechek, J. C. 1984. Impacts of grazing intensity and specialized grazing systems on livestock response. Pages 1129-1158 in N. A. of S. National Research Council, editor. Developing strategies for rangeland management. Westview Press, Boulder.
13562. Marcuson, P. E. 1977. The effect of cattle grazing on brown trout in Rock Creek, Montana, 1st Edition. Montana Department of Fish and Game, Fisheries Division, Special Report, Helena, Project No. F-20-R-21, II-a.
12839. Marlow, C. B., and T. M. Pogacnik. 1985. Time of grazing and cattle-induced damage to streambanks. Paper presented at the North American Riparian conference at the University of Arizona, Tucson, April 15-19, 1985 Pages 279-284.
8954. Marlow, C. B., K. Olson-Rutz, and J. Atchley. 1989. Response of a Southwest Montana riparian system to four grazing management alternatives. Pages 111-116 in R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.

12841. Marlow, D. B., and T. M. Pogacnik. 1986. Cattle feeding and resting patterns in a foothills riparian zone. *Journal of Range Management* 39:212-217.
12840. Marlow, D. B., T. M. Pogacnik, and S. D. Quinsey. 1987. Streambank stability and cattle grazing in southwestern Montana. *Journal of Soil and Water Conservation* July-August:291-296.
6468. Martin, S. C. 1979. Evaluating the impacts of cattle grazing on riparian habitats in the national forests of Arizona and New Mexico. Pages 35-38 *in* O. B. Cope, editor. *Proceedings of the Forum - Grazing and riparian/stream ecosystems at Denver, CO, Nov. 3-4, 1978*. Trout Unlimited, Inc., Vienna, Virginia.
13459. May, B. E., and B. Davis. 1981. Practices for livestock grazing and aquatic habitat protection on western rangelands. Pages 271-278 *in* J. M. Peek and P. D. Dalke, editors. *Wildlife - livestock relationships symposium - Proceedings 10*. University of Idaho, Forest Wildlife and Range Experiment Station, Moscow.
12842. Mazaika, R., P. R. Krausman, and R. C. Etchberger. 1992. Forage availability for mountain sheep in Pusch Ridge Wilderness, Arizona. *The Southwestern Naturalist* 37:372-378.
12843. Mcclaran, M. P. 1991. Forest Service and livestock permittee behavior in relation to wilderness designation. *Journal of Range Management* 44:483-486.
13701. McDougald, N. K., W. E. Frost, and D. E. Jones. 1989. Use of supplemental feeding locations to manage cattle use on riparian areas of hardwood rangelands. Pages 124-126 *in* D. L. Abell, editor. *Proceedings of the California riparian systems conference: protection, management, and restoration for the 1990s; 1988 September 22-24; Davis, CA*. Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, Berkeley, CA, Gen. Tech. Rep. PSW-110.
13461. Medin, D. E., and W. P. Clary. 1989. Small mammal populations in a grazed and ungrazed riparian habitat in Nevada, 1st Edition. USDA, Forest Service, Intermountain Research Station, Ogden, Res. Pap. INT-413.
13563. ---. 1990. Bird and small mammal populations in a grazed and ungrazed riparian habitat in Idaho, 1st Edition. USDA, Forest Service, Intermountain Research Station, Ogden, Research Paper INT-425.

4093. ---. 1991. Breeding bird populations in a grazed and ungrazed riparian habitat in Nevada. USDA, Forest Service, Intermountain Research Station, Ogden, UT, Research Paper # INT-441.
1794. Meehan, W. R., and W. S. Platts. 1978. Livestock grazing and the aquatic environment. *Journal of Soil and Water Conservation* 33:274-278.
12844. Moring, J. R., G. C. Garman, and D. M. Mullen. 1985. The value of riparian zones for protecting aquatic systems: General concerns and recent studies in Maine. Paper presented at the North American riparian conference in Tuscon, AZ April 16-18, 1985, 315-319.
13564. Mosconi, S. L., and R. L. Hutto. 1981. The effect of grazing on the land birds on a western Montana riparian habitat. Pages 221-233 in *Proceedings of the wildlife-livestock relationships symposium*. Forest, Wildlife & Range Experiment Station, University of Idaho, Moscow.
13793. Moulton, M. 1978. Small mammal associations in grazed versus ungrazed cottonwood riparian woodland in Eastern Colorado. Pages 133-140 in W. D. Graul and S. J. Bissell, editors. Lowland river and stream habitat in Colorado: a symposium. Colorado Chapter of Wildlife Society and Colorado Audubon Council, Greeley, CO.
13669. Mundinger, J. G. 1976. Waterfowl response to rest-rotation grazing. *Journal of Wildlife Management* 40:60-68.
13458. Munther, G. L. 1981. Beaver management in grazed riparian ecosystems. Pages 234-241 in J. M. Peek and P. D. Dalke, editors. *Wildlife - livestock relationships symposium - Proceedings 10*. University of Idaho, Forest Wildlife and Range Experiment Station, Moscow.
8955. Myers, L. H. 1989. Grazing and riparian management in southwestern Montana. Pages 117-120 in R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. *Practical approaches to riparian resource management - an educational workshop*. U. S. Bureau of Land Management, Billings, Montana.
4166. Myers, T. J., and S. Swanson. 1991. Aquatic habitat condition index, stream type, and livestock bank damage in northern Nevada. *Water Resources Research* 27:667-677.
7305. ---. 1992. Variation of stream stability with stream type and livestock bank damage in Northern Nevada. *Water Resources Bulletin* 28:743-754.

8940. Nedeff, N. 1989. Cooperative resource management on the Muleshoe Ranch Preserve. Pages 7-9 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.
13565. Neel, J. P., H. E. Kiesling, G. B. Donart, J. L. Holechek, J. D. Goodman, and D. Manzanares. 1986. Nutritive value of riparian and upland forage collected by esophageal fistulated cattle on forest land. *Journal of Animal Science* 63:380.
6462. Noh, L. 1979. Grazing riparian/stream ecosystems on federal lands-the livestock producers' viewpoint. Pages 3-4 *in* O. B. Cope, editor. Proceedings of the Forum - Grazing and riparian/stream ecosystems at Denver, CO, Nov. 3-4, 1978. Trout Unlimited, Inc., Vienna, Virginia.
12845. Oedekoven, O. O., and F. G. Lindzey. 1987. Winter habitat-use patterns of elk, mule deer and moose in southwestern Wyoming. *Great Basin Naturalist* 47:638-643.
13428. Olson, T. E., and F. L. Knopf. 1988. Patterns of relative diversity within riparian small mammal communities, Platte River Watershed, Colorado. Pages 379-386 *in* Management of amphibians, reptiles, and small mammals in North America. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins.
12576. Overton, C. K., G. L. Chandler, and J. A. Pisano. 1994. Northern/Intermountain regions' fish habitat inventory: Grazed, rested, and ungrazed reference stream reaches, Silver King Creek, California, 1st Edition. United States Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT, Gen. Tech. Rep. No. INT-GTR-311.
13460. Parker, M. 1986. Beaver, water quality, and riparian systems. Pages 88-94 *in* Proceedings of the Wyoming water 1986 and streamside zone conference. Wyoming Water Research Center, UW Agricultural Extension Service, Casper.
8941. Phinney, D. E., M. S. Deusen, S. M. Keller, and P. A. Knudsen. 1989. A new approach to riparian management in Washington state. Pages 11-15 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.

13423. Pieper, R. D. 1994. Ecological implications of livestock grazing. Pages 177-211 *in* M. Vavra, W. A. Laycock and R. D. Pieper, editors. Ecological implications of livestock herbivory in the West. Society for Range Management, Denver.
13420. Pister, E. P. 1981. Cows, trout, and wilderness. Pages 61 *in* K. A. Hashagan, editor. Habitat disturbance and recovery. California Trout, Inc., San Francisco.
13422. Platta, W. S. 1978. Livestock interactions with fish and aquatic environments: Problems in evaluation. Pages 498-504 *in* 43rd North American and Natural Resource Conference. Wildlife Management Institute, Washington, D.C.
13455. Platts, W. S. 1978. Livestock interactions with fish and their environments: A symposium summary. Cal-Nevada Wildlife Transactions :92-96.
2879. ---. 1979. Livestock grazing and riparian/stream ecosystems - an overview. Pages 39-45 *in* O. B. Cope, editor. Proceedings, Forum - grazing and riparian/stream ecosystems. Trout Unlimited, Inc., Vienna, Virginia.
13568. ---. 1981a. Sheep and cattle grazing strategies on riparian-stream environments. Pages 251-270 *in* Proceedings of the wildlife-livestock relationships symposium. Forest, Wildlife & Range Experiment Station, University of Idaho, Moscow.
13566. ---. 1981b. Sheep and streams. Rangelands 3:158-160.
13665. ---. 1984. Riparian system/livestock grazing interaction research in the Intermountain West. Pages 424-429 *in* R. E. Warner and K. M. Hendrix, editors. California riparian systems - Ecology, conservation, and productive management. University of California Press, LTD., London, England.
13108. ---. 1985. Riparian-stream management. Pages 70-74 *in* National range conference proceedings. USDA, .
13449. ---. 1986. Managing riparian stream habitats. Pages 59-62 *in* Proceedings of the Wyoming water 1986 and streamside zone conference. Wyoming Water Research Center, UW Agricultural Extension Service, Casper.
8953. ---. 1989. Compatibility of livestock grazing strategies with fisheries.

- Pages 103-110 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.
13447. Platts, W. S., and G. F. Gifford. 1986. Public and private rangeland management: An overview. Pages 261-264 *in* R. E. McCabe, editor. Transactions of the fifty-first North American wildlife and natural resources conference. Wildlife Management Institute, Washington, D.C.
13090. Platts, W. S., and R. L. Nelson. 1985a. Impacts of rest-rotation grazing on stream banks in forested watersheds in Idaho. North American Journal of Fisheries Management 5:547-556.
13453. ---. 1985b. Streamside and upland vegetation use by cattle. Rangelands 7:5-7.
13567. ---. 1985c. Will the riparian pasture build good streams? Rangelands 7:7-10.
8949. ---. 1989. Characteristics of riparian plant communities and streambanks with respect to grazing in Northeastern Utah. Pages 73-81 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.
13105. Platts, W. S., and R. F. Raleigh. 1984. Impacts of grazing on wetlands and riparian habitat. Pages 1105-1117 *in* N. A. of S. National Research Council, editor. Developing strategies for rangeland management. Westview Press, Boulder.
6442. Platts, W. S., C. Armour, G. D. Booth, M. Bryant, J. L. Bufford, S. Jensen, G. W. Lienkaemper, G. W. Minshall, S. B. Monsen, R. L. Nelson, J. R. Sedell, and J. S. Tuhy. 1987. Methods for evaluating riparian habitats with application to management. Intermountain Research Station, Forest Service, USDA, Ogden, UT, INT-221.
13095. Platts, W. S., F. J. Wagstaff, and E. Chaney. 1989. Cattle and fish on the Henry's Fork. Rangelands 11:58-62.
12846. Popolizio, C. A., H. Goetz, and P. L. Chapman. 1994. Short-term response of riparian vegetation to 4 grazing treatments. Journal of Range Management 47:48-53.
13117. Prichard, D. 1993. Riparian Area Management: Process for assessing

- proper functioning condition, 1st Edition. U.S. Department of Interior, Bureau of Land Management, Proper Functioning Condition Work Group, Denver, TR 1737-9 1993.
13664. Prichard, D. E., and L. L. Upham. 1986. Texas Creek riparian enhancement study. Pages 298-303 *in* R. E. McCabe, editor. Transactions of the Fifty-first North American Wildlife and Natural Resource Conference. Wildlife Management Institute, Washington, D.C.
9095. Quinn, J. M., R. B. Williamson, R. K. Smith, and M. L. Vickers. 1992. Effects of riparian grazing and channelisation on streams in Southland, New Zealand. 2. Benthic invertebrates. New Zealand Journal of Marine and Freshwater Research 26:259-273.
9716. Reichard, N. 1984. Riparian habitat restoration: Some techniques for dealing with landowners, livestock, and eroding streambacks. Pages 128-137 *in* T. J. Hassler, editor. Pacific Northwest stream habitat management workshop. American Fisheries Society, Western Division, Humboldt Chapter, Arcata, CA.
803. Rickard, W. H., and C. E. Cushing. 1982. Recovery of streamside woody vegetation after exclusion of livestock grazing. Journal of Range Management 35:360-361.
12974. Rinne, J. N. 1985. Livestock grazing effects on Southwestern streams: A complex research problem. Pages 295-299 *in* Symposium - Riparian ecosystems and their management: Reconciling conflicting uses, April 16-18, Tucson, AZ., .
13094. ---. 1988a. Effects of livestock grazing exclosure on aquatic macroinvertebrates in a montane stream, New Mexico. Great Basin Naturalist 48:146-153.
13097. ---. 1988b. Grazing effects on stream habitat and fishes: Research design considerations. North American Journal of Fisheries Management 8:240-247.
14284. ---. 1990. Minimizing livestock grazing effects on riparian stream habitats: Recommendations for research and management. Enhancing states' lake/wetlands programs 1990:15-28.
13795. Rittenhouse, L. R. 1984. "Impacts of grazing intensity and specialized grazing systems on livestock response": A discussant paper. Pages 1159-1165 *in* N. A. of S. National Research Council, editor. Developing strategies for rangeland management. Westview Press, Boulder.

7386. Roath, L. R., and W. C. Krueger. 1982. Cattle grazing influence on a mountain riparian zone. *Journal of Range Management* 35:100-103.
12967. Rood, S. B., and J. M. Mahoney. 1990. Collapse of riparian poplar forests downstream from dams in western prairies: Probable causes and prospects for mitigation. *Environmental Management* 14:451-464.
13569. Rucks, J. A. 1978. Comparisons of riparian communities influenced by grazing. Pages 100-113 *in* W. D. Graul and S. J. Bissell, editors. Lowland river and stream habitat in Colorado: a symposium (Greeley, CO, Oct. 4-5, 1978). Colorado Chapter of the Wildlife Society and Colorado Audubon Council, Greeley, CO.
6466. Rupp, C. W. 1979. Management and policy for grazing riparian ecosystems on national forest system lands. Pages 17-19 *in* O. B. Cope, editor. *Proceedings of the Forum - Grazing and riparian/stream ecosystems at Denver, CO, Nov. 3-4, 1978*. Trout Unlimited, Inc., Vienna, Virginia.
13442. Ryder, R. A. 1980. Effects of grazing on bird habitats. Pages 51-66 *in* Management of western forests and grasslands for nongame birds. USDA, Forest Service, Intermountain Forest and Range Experiment Station, Rocky Mountain Forest and Range Experiment Station, and Intermountain Region, Ogden, Gen. Tech. Rep. No. INT-86.
13092. Sartz, R. S., and D. N. Tolsted. 1974. Effect of grazing on runoff from two small watersheds in southwestern Wisconsin. *Water Resources Research* 10:354-356.
12963. Schulz, J. T., and W. C. Leininger. 1990. Differences in riparian vegetation structure between grazed areas and exclosures. *Journal of Range Management* 43:295-299.
13098. Sedgwick, J. A., and F. L. Knopf. 1987. Breeding bird response to cattle grazing of a Cottonwood bottomland. *Journal of Wildlife Management* 51:230-237.
12962. ---. 1991. Prescribed grazing as a secondary impact in a western riparian floodplain. *Journal of Range Management* 44:369-373.
13109. Severson, K. E., and A. V. Carter. 1978. Movements and habitat use by mule deer in the Northern Great Plains, South Dakota. Pages 466-468 *in* D. N. Hyder, editor. *Proceedings of the first international rangeland congress*. Society for Range Management, Denver.

13426. Severson, K. E., and P. J. Urness. 1994. Livestock grazing: A tool to improve wildlife habitat. Pages 232-249 *in* M. Vavra, W. A. Laycock and R. D. Pieper, editors. Ecological implications of livestock herbivory in the West. Society for Range Management, Denver.
8943. Shepard, B. B. 1989. Evaluation of the U.S. Forest Service "COWFISH" Model for assessing livestock impacts on fisheries in the Beaverhead National Forest, Montana. Pages 23-33 *in* R. E. Gresswell, B. A. Barton and J. L. Kershner, editors. Practical approaches to riparian resource management - an educational workshop. U. S. Bureau of Land Management, Billings, Montana.
12975. Siekert, R. E., Q. D. Skinner, M. A. Smith, J. L. Dodd, and J. D. Rodgers. 1985. Channel response of an ephemeral stream in Wyoming to selected grazing treatments. Pages 276-278 *in* Symposium - Riparian ecosystems and their management: Reconciling conflicting uses, April 16-18, Tuscon, AZ., .
13091. Skinner, Q. D., J. C. Adams, P. A. Rechard, and A. A. Beetle. 1974. Effect of summer use of a mountain watershed on bacterial water quality. Journal of Environmental Quality 3:329-335.
13116. Skovlin, J. M. 1984. Impacts of grazing on wetlands and riparian habitat: A review of our knowledge. Pages 1001-1103 *in* National Academy of Science National Research Council, editor. Developing strategies for rangeland management. Westview Press, Boulder.
13450. Smith, B. H. 1986. Grazing exclosures and natural rehabilitation of eroding streams. Pages 85-87 *in* Proceedings of the Wyoming water 1986 and streamside zone conference. Wyoming Water Research Center, UW Agricultural Extension Service, Casper.
13114. Smith, B., and D. Prichard. 1992. Riparian Area Management: Management techniques in riparian areas, 1st Edition. U.S. Department of Interior, Bureau of Land Management, Denver, TR 1737-6 1992.
12961. Smith, C. M. 1989. Riparian pasture retirement effects on sediment, phosphorus, and nitrogen in channelised surface run-off from pastures. New Zealand Journal of Marine and Freshwater Research 23:139-146.
4507. Smith, M. A., J. D. Rodgers, J. L. Dodd, and Q. D. Skinner. 1992. Habitat selection by cattle along an ephemeral channel. Journal of Range Management 45:385-390.
13432. Snyder, N. F. R., and H. A. Snyder. 1975. Raptors in range habitat.

- Pages 190-209 *in* D. R. Smith, editor. Proceedings of the symposium on management of forest and range habitats for nongame birds. USDA, Forest Service, Washington, D.C.
12970. Strassmann, B. I. 1987. Effects of cattle grazing and haying on wildlife conservation at National wildlife refuges in the United States. *Environmental Management* 11:35-44.
12973. Stuber, R. J. 1985. Trout habitat, adundance, and fishing opportunities in fences vs. unfenced riparian habitat along Sheep Creek, Colorado. Pages 310-314 *in* Symposium - Riparian ecosystems and their management: Reconciling conflicting uses, April 16-18, Tuscon, AZ., .
13451. Sun, K. R. 1986. Ranch management of streamside zones. Pages 155-166 *in* Proceedings of the Wyoming water 1986 and streamside zone conference. Wyoming Water Research Center, UW Agricultural Extension Service, Casper.
6461. Swan, B. 1979. Riparian habitat - the cattlemen's viewpoint. Pages 4-6 *in* O. B. Cope, editor. Proceedings of the Forum - Grazing and riparian/stream ecosystems at Denver, CO, Nov. 3-4, 1978. Trout Unlimited, Inc., Vienna, Virginia.
13096. Swanson, S. 1989a. Priorities for riparian management. *Rangelands* 11:228-230.
13700. ---. 1989b. Using stream classification to prioritize riparian rehabilitation after extreme events. Pages 96-101 *in* D. L. Abell, editor. Proceedings of the California riparian systems conference: protection, management, and restoration for the 1990s; 1988 September 22-24; Davis, CA. Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, Berkeley, CA, Gen. Tech. Rep. PSW-110.
13465. ---. 1993a. Options for riparian grazing management. Pages Fact sheet 86-77 *in* Watershed management guide for the interior Northwest. Oregon State University Extension Service, Corvallis.
13473. Swanson, S. S. 1993b. Prioritizing streams for rehabilitation and riparian management. Pages Fact sheet 88-76 *in* Watershed management guide for the interior Northwest. Oregon State University Extension Service, Corvallis.
13466. Swanson, S. 1993c. Riparian pastures. Pages Fact sheet 87-53 *in* Watershed management guide for the interior Northwest. Oregon State University Extension Service, Corvallis.

13464. ---. 1993d. The value of healthy riparian areas. Pages Fact sheet 86-76 in Watershed management guide for the interior Northwest. Oregon State University Extension Service, Corvallis.
12972. Szaro, R. C. 1991. Wildlife communities of Southwestern riparian ecosystems. Pages 174-201 in J. E. Rodiek and E. G. Bolen, editors. Wildlife and habitats in managed landscapes. Island Press, Washington, D.C.
12971. Szaro, R. C., and C. P. Pase. 1983. Short-term changes in a Cottonwood-Ash-Willow association on a grazed and an ungrazed portion of Little Ash Creek in Central Arizona. Journal of Range Management 36:382-384.
13570. Szaro, R. C., and J. N. Rinne. 1988. Ecosystem approach to management of Southwestern riparian communities. Pages 502-511 in R. E. McCabe, editor. Transactions of the fifty-third North American wildlife and natural resources conference. Wildlife Management Institute, Washington, D.C.
13571. Szaro, R. C., S. C. Belfit, J. K. Aitkin, and R. D. Babb. 1988. The use of times fixed-area plots and a mark-recapture technique in assessing riparian garter snake populations. Pages 239-246 in Management of amphibians, reptiles, and small mammals in North America - Proceedings of the symposium. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Gen. Tech. Rep. RM-166.
13093. Taylor, D. M. 1986. Effects of cattle grazing on passerine birds nesting in riparian habitat. Journal of Range Management 39:254-258.
2379. Thomas, J. W., C. Maser, and J. E. Rodiek. 1979. Riparian Zones. Pages 18 in J. W. Thomas and Maser.C, editors. Wildlife habitats in managed rangelands --the Great Basin of Southeastern Oregon. USDA, Pacific Northwest Forest and Range Experimental Station, Portland, OR, Gen. Tech. Rep. PNW-80.
6470. Velson, R. V. 1979. Effects of livestock grazing upon rainbow trout in Otter Creek, Nebraska. Pages 53-55 in O. B. Cope, editor. Proceedings of the Forum - Grazing and riparian/stream ecosystems at Denver, CO, Nov. 3-4, 1978. Trout Unlimited, Inc., Vienna, Virginia.
13572. Vogler, J. P. 1978. Effects of grazing, clearing, and stream channelization on riparian and associated vegetation of Guthrie County, Iowa. Master of Science Thesis. Iowa State University, Ames.

11817. Wagner, F. H. 1994. Changing institutional arrangements for setting natural-resources policy. Pages 281-288 *in* M. Vavra, W. A. Laycock and R. D. Pieper, editors. Ecological implications of livestock herbivory in the West. Society for Range Management, Denver, CO.
13448. Wagstaff, F. J. 1986. Economic issues of grazing and riparian area management. Pages 272-279 *in* R. E. McCabe, editor. Transactions of the fifty-first North American wildlife and natural resources conference. Wildlife Management Institute, Washington, D.C.
13113. Weeth, H. J. 1973. Non-applicability of Federal water quality standards when applied to cattle. Pages 9-14 *in* H. F. Mayland, editor. Water-animal relations proceedings. Water-Animal Relations Committee, Kimberly.
13666. Whyte, R. J., and B. W. Cain. 1981. Wildlife habitat on grazed or ungrazed small pond shorelines in South Texas. Journal of Range Management 34:64-68.
13430. Wiens, J. A., and M. I. Dyer. 1975. Rangeland avifaunas: Their composition, energetics, and role in the ecosystem. Pages 146-182 *in* D. R. Smith, editor. Proceedings of the symposium on management of forest and range habitats for nongame birds. USDA, Forest Service, Washington, D.C., Gen. Tech. Rep. WO-1.
5177. Williamson, R. B., R. K. Smith, and J. M. Quinn. 1992. Effects of riparian grazing and channelisation on streams in Southland, New Zealand. 1. Channel form and stability. New Zealand Journal of Marine and Freshwater Research 26:241-258.
13663. Winget, R. N., and M. K. Reichert. 1976. Aquatic survey of selected streams with critical habitats on national resource lands affected by livestock and recreation, 1st Edition. U.S. Bureau of Land Management,
15355. Winward, A. H. 1994. Management of livestock in riparian areas. Pages 49-52 *in* G. A. Rasmussen and J. P. Dobrowolski, editors. Riparian resources, 1st Edition. Volume 1. Utah State University, College of Natural Resources, Logan.
13089. Wood, J. C., and M. K. Wood. 1988. Infiltration and water quality on range sites at Fort Stanton, New Mexico. Water Resources Bulletin 2:317-323.

Appendix B. Summary of data from studies examining the effects of livestock grazing on different attributes of riparian ecosystems. Sources of data are keyed by reference number as listed in Appendix A.

Ref#	Year	Site	Treatment	Variable	Measure	Units	Species or subcategory	Result	Stat Sig?	1.5x?	E/O
13098	1982	South Platte River	Ungrazed	Birds	Density	100/ha	All birds	71.54			
13098	1982	South Platte River	Grazed	Birds	Density	100/ha	All birds	69.23		N	E
13560	1978-1979	Catherine Creek	Ungrazed	Birds	Density	#/ha	Kentucky bluegrass-mixed forbs	6.67			
13560	1978-1979	Catherine Creek	Grazed	Birds	Density	#/ha	Kentucky bluegrass-mixed forbs	10.17	Y	O	
13560	1978-1979	Catherine Creek	Ungrazed	Birds	Density	#/ha	Douglas Hawthorne-kentucky bluegrass	11.30			
13560	1978-1979	Catherine Creek	Grazed	Birds	Density	#/ha	Douglas Hawthorne-kentucky bluegrass	16.50		N	O
13560	1978-1979	Catherine Creek	Ungrazed	Birds	Density	#/ha	Black cottonwood-mixed conifer	14.00			
13560	1978-1979	Catherine Creek	Grazed	Birds	Density	#/ha	Black cottonwood-mixed conifer	27.17	Y	O	
13563	1989	Summit Creek	Ungrazed	Birds	H'			2.52			
13563	1989	Summit Creek	Grazed	Birds	H'			4.07	Y	O	
13554	1959-1961	South Platte River	Ungrazed	Birds	H'			0.35			
13554	1959-1961	South Platte River	Grazed	Birds	H'			0.47		N	O
13569	1978	Upper Gunnison	Ungrazed	Birds	H'		Male based	1.69			
13569	1978	Upper Gunnison	Grazed	Birds	H'		Male based	1.81		N	O
13560	1978-1979	Catherine Creek	Ungrazed	Birds	H'		Kentucky bluegrass-mixed forbs	1.53			
13560	1978-1979	Catherine Creek	Grazed	Birds	H'		Kentucky bluegrass-mixed forbs	1.31		N	E
13560	1978-1979	Catherine Creek	Ungrazed	Birds	H'		Douglas Hawthorne-kentucky bluegrass	1.85			
13560	1978-1979	Catherine Creek	Grazed	Birds	H'		Douglas Hawthorne-kentucky bluegrass	2.02		N	O
13560	1978-1979	Catherine Creek	Ungrazed	Birds	H'		Black cottonwood-mixed conifer	1.58			
13560	1978-1979	Catherine Creek	Grazed	Birds	H'		Black cottonwood-mixed conifer	2.03		N	O
13570	1985-1986	Rio de las Vacas	Ungrazed	Birds	Number			835.00			
13570	1985-1986	Rio de las Vacas	Grazed	Birds	Number			500.50	Y	E	
13569	1978	Upper Gunnison	Ungrazed	Birds	Number			39.56			
13569	1978	Upper Gunnison	Grazed	Birds	Number			31.17		N	E
13570	1985-1986	Rio de las Vacas	Ungrazed	Birds	S			44.75			
13570	1985-1986	Rio de las Vacas	Grazed	Birds	S			35.00		N	E
13563	1989	Summit Creek	Ungrazed	Birds	S			4.00			
13563	1989	Summit Creek	Grazed	Birds	S			7.00	Y	O	
13569	1978	Upper Gunnison	Ungrazed	Birds	S			10.67			
13569	1978	Upper Gunnison	Grazed	Birds	S			11.95		N	O
13560	1978-1979	Catherine Creek	Ungrazed	Birds	S		Kentucky bluegrass-mixed forbs	8.50			
13560	1978-1979	Catherine Creek	Grazed	Birds	S		Kentucky bluegrass-mixed forbs	8.17		N	E

Ref#	Year	Site	Treatment	Variable	Measure	Units	Species or subcategory	Result	Stat Sig?	1.5x?	E/O
13560	1978-1979	Catherine Creek	Ungrazed	Birds	S		Douglas Hawthorne-kentucky bluegrass	8.83			
13560	1978-1979	Catherine Creek	Grazed	Birds	S		Douglas Hawthorne-kentucky bluegrass	11.67	N	O	
13560	1978-1979	Catherine Creek	Ungrazed	Birds	S		Black cottonwood-mixed conifer	8.67			
13560	1978-1979	Catherine Creek	Grazed	Birds	S		Black cottonwood-mixed conifer	13.67	Y	O	
13094	1983-1984	Rio de las Vacas	Ungrazed	Bugs	BCI			79.00			
13094	1983-1984	Rio de las Vacas	Grazed	Bugs	BCI			68.50	N	E	
13094	1983	Rio de las Vacas	Ungrazed	Bugs	Biomass	g/sq m	All bugs	764.70			
13094	1983	Rio de las Vacas	Grazed	Bugs	Biomass	g/sq m	All bugs	1110.76	Y	O	
13663	1975	Big Creek	Ungrazed	Bugs	H'		Macroinvertebrate	1.97			
13663	1975	Big Creek	Grazed	Bugs	H'		Macroinvertebrate	2.09	N	O	
13094	1983-1984	Rio de las Vacas	Ungrazed	Bugs	H'			2.86			
13094	1983-1984	Rio de las Vacas	Grazed	Bugs	H'			3.63	N	O	
13663	1975	Big Creek	Ungrazed	Bugs	Number	#/sq m	Macroinvertebrate	41347.00			
13663	1975	Big Creek	Grazed	Bugs	Number	#/sq m	Macroinvertebrate	38752.00	N	O	
13094	1983-1984	Rio de las Vacas	Ungrazed	Bugs	Number	#/sq m	All bugs	959.30			
13094	1983-1984	Rio de las Vacas	Grazed	Bugs	Number	#/sq m	All bugs	1958.00	Y	E	
13663	1975	Big Creek	Ungrazed	Bugs	S		Macroinvertebrate	29.30			
13663	1975	Big Creek	Grazed	Bugs	S		Macroinvertebrate	28.00	N	E	
13094	1983-1984	Rio de las Vacas	Ungrazed	Bugs	S		Major groups	58.00			
13094	1983-1984	Rio de las Vacas	Grazed	Bugs	S		Major groups	60.00	N	O	
13094	1983-1984	Rio de las Vacas	Ungrazed	Bugs	TQ			69.25			
13094	1983-1984	Rio de las Vacas	Grazed	Bugs	TQ			79.50	N	E	
802	1978	Wstrn Washington	Ungrazed	Fish	Biomass	g/sq m	All Salmonids	3.64			
802	1978	Wstrn Washington	Grazed	Fish	Biomass	g/sq m	All Salmonids	3.75	N	O	
12973	1983-1984	Sheep Creek	Ungrazed	Fish	Biomass	kg/ha	All Trout	159.00			
12973	1983-1984	Sheep Creek	Grazed	Fish	Biomass	kg/ha	All Trout	76.50	Y	E	
13562	1964-1968	Rock Creek	Ungrazed	Fish	Biomass	kg/ha		238.83			
13562	1964-1968	Rock Creek	Grazed	Fish	Biomass	kg/ha		71.04	Y	E	
13562	1969	Rock Creek	Ungrazed	Fish	Biomass	kg/ha	All Fish	375.37			
13562	1969	Rock Creek	Grazed	Fish	Biomass	kg/ha	All Fish	88.41	Y	E	
12974	1982	Rio de las Vacas	Ungrazed	Fish	Number	#/50 m	All Fish	151.70			
12974	1982	Rio de las Vacas	Grazed	Fish	Number	#/50 m	All Fish	354.80	Y	O	
12974	1982	Rio de las Vacas	Ungrazed	Fish	Biomass	g/50 m	All Fish	2858.70			
12974	1982	Rio de las Vacas	Grazed	Fish	Biomass	g/50 m	All Fish	2364.50	N	E	
12973	1983-1984	Sheep Creek	Ungrazed	Fish	Density	%	Rel. Abundance, All Trout	96.50			

Ref#	Year	Site	Treatment	Variable	Measure	Units	Species or subcategory	Result	Stat Sig?	1.5x?	E/O
12973	1983-1984	Sheep Creek	Grazed	Fish	Density	%	Rel. Abundance, All Trout	85.00		N	E
13562	1964-1968	Rock Creek	Ungrazed	Fish	Density	#/ha		4645.00			
13562	1964-1968	Rock Creek	Grazed	Fish	Density	#/ha		1733.00		Y	E
13562	1969	Rock Creek	Ungrazed	Fish	Density	#/ha	All Fish	5373.00			
13562	1969	Rock Creek	Grazed	Fish	Density	#/ha	All Fish	2639.00		Y	E
13562	1967	Rock Creek	Ungrazed	Geom	Pools	#/km	Before flood	34.00			
13562	1967	Rock Creek	Grazed	Geom	Pools	#/km	Before flood	23.40		N	E
802	1978	Wstrn Washington	Ungrazed	Geom	Riffle	%		43.00			
802	1978	Wstrn Washington	Grazed	Geom	Riffle	%		38.00	N	N	O
12576	1991	Coyote Valley Crk	Ungrazed	Geom	Surface fines	%	Pools only	40.50			
12576	1991	Coyote Valley Crk	Grazed	Geom	Surface fines	%	Pools only	26.90		N	O
12576	1991	Silver King Creek	Ungrazed	Geom	Surface fines	%	Riffles only	9.00			
12576	1991	Silver King Creek	Grazed	Geom	Surface fines	%	Riffles only	15.10		N	E
13068	1984	Cherry Creek	Ungrazed	Geom	Surface fines	%	Silt substrate	13.00			
13068	1984	Cherry Creek	Grazed	Geom	Surface fines	%	Silt substrate	22.00	Y	Y	E
802	1978	Wstrn Washington	Ungrazed	Geom	Surface fines	%	Sand or finer	32.00			
802	1978	Wstrn Washington	Grazed	Geom	Surface fines	%	Sand or finer	40.50	N	N	E
12576	1991	Coyote Valley Crk	Ungrazed	Geom	Volume	m cubed	Pools only - residual	2.20			
12576	1991	Coyote Valley Crk	Grazed	Geom	Volume	m cubed	Pools only - residual	3.20		N	O
12576	1991	Silver King Creek	Ungrazed	Geom	Volume	m cubed	Pools only - residual	46.00			
12576	1991	Silver King Creek	Grazed	Geom	Volume	m cubed	Pools only - residual	54.00		N	O
802	1978	Wstrn Washington	Ungrazed	Geom	Volume	m cubed	Pool, glide	21.00			
802	1978	Wstrn Washington	Grazed	Geom	Volume	m cubed	Pool, glide	25.50	N	N	O
12576	1991	Coyote Valley Crk	Ungrazed	Geom	W/D	m		3.25			
12576	1991	Coyote Valley Crk	Grazed	Geom	W/D	m		7.30	Y	E	
12576	1991	Silver King Creek	Ungrazed	Geom	W/D	m		18.40			
12576	1991	Silver King Creek	Grazed	Geom	W/D	m		22.05	N	E	
13562	1968	Rock Creek	Ungrazed	Geom	W/D	m		19.40			
13562	1968	Rock Creek	Grazed	Geom	W/D	m		28.50	N	E	
13068	1984	Cherry Creek	Ungrazed	Geom	W/D	m		28.00			
13068	1984	Cherry Creek	Grazed	Geom	W/D	m		37.00	Y	N	E
12973	1984	Sheep Creek	Ungrazed	Geom	W/D	m		18.50			
12973	1984	Sheep Creek	Grazed	Geom	W/D	m		55.00	Y	E	
13663	1975	Big Creek	Ungrazed	Geom	W/D	ft		0.07			
13663	1975	Big Creek	Grazed	Geom	W/D	ft		0.04	N	O	

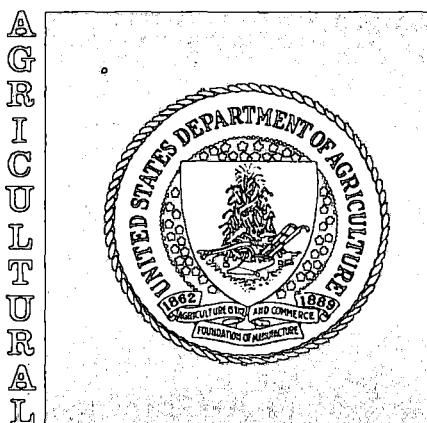
Ref#	Year	Site	Treatment	Variable	Measure	Units	Species or subcategory	Result	Stat Sig?	1.5x?	E/O
13560	1978-1979	Catherine Creek	Ungrazed	Mammals	Density	#/ha	Kentucky bluegrass-mixed forbs	316.50			
13560	1978-1979	Catherine Creek	Grazed	Mammals	Density	#/ha	Kentucky bluegrass-mixed forbs	247.50	N	E	
13560	1978-1979	Catherine Creek	Ungrazed	Mammals	Density	#/ha	Douglas Hawthorne-kentucky bluegrass	344.70			
13560	1978-1979	Catherine Creek	Grazed	Mammals	Density	#/ha	Douglas Hawthorne-kentucky bluegrass	304.30	N	E	
13560	1978-1979	Catherine Creek	Ungrazed	Mammals	Density	#/ha	Black cottonwood-mixed conifer	196.30			
13560	1978-1979	Catherine Creek	Grazed	Mammals	Density	#/ha	Black cottonwood-mixed conifer	73.00	Y	E	
13560	1978-1979	Catherine Creek	Ungrazed	Mammals	H'		Kentucky bluegrass-mixed forbs	0.48			
13560	1978-1979	Catherine Creek	Grazed	Mammals	H'		Kentucky bluegrass-mixed forbs	0.71	N	O	
13560	1978-1979	Catherine Creek	Ungrazed	Mammals	H'		Douglas Hawthorne-kentucky bluegrass	0.62			
13560	1978-1979	Catherine Creek	Grazed	Mammals	H'		Douglas Hawthorne-kentucky bluegrass	0.03	Y	E	
13560	1978-1979	Catherine Creek	Ungrazed	Mammals	H'		Black cottonwood-mixed conifer	1.03			
13560	1978-1979	Catherine Creek	Grazed	Mammals	H'		Black cottonwood-mixed conifer	0.52	Y	E	
13559	1977	Medicine Lodge	Ungrazed	Mammals	H'		Small Mammals	1.53			
13559	1977	Medicine Lodge	Grazed	Mammals	H'		Small Mammals	1.29	N	E	
13559	1974	Big Hole Mtns	Ungrazed	Mammals	H'		Small Mammals	1.70			
13559	1974	Big Hole Mtns	Grazed	Mammals	H'		Small Mammals	1.97	N	O	
13570	1985	Rio de las Vacas	Ungrazed	Mammals	Number		Small mammals	91.75			
13570	1985	Rio de las Vacas	Grazed	Mammals	Number		Small mammals	38.50	Y	E	
13559	1977	Medicine Lodge	Ungrazed	Mammals	Number	#/100 trap nights	Small Mammals	8.00			
13559	1977	Medicine Lodge	Grazed	Mammals	Number	#/100 trap nights	Small Mammals	6.00	N	E	
13559	1974	Big Hole Mtns	Ungrazed	Mammals	Number	#/100 trap nights	Small Mammals	58.80			
13559	1974	Big Hole Mtns	Grazed	Mammals	Number	#/100 trap nights	Small Mammals	20.50	Y	E	
13570	1985	Rio de las Vacas	Ungrazed	Mammals	S			7.25			
13570	1985	Rio de las Vacas	Grazed	Mammals	S			5.00	N	E	
13560	1978-1979	Catherine Creek	Ungrazed	Mammals	S		Kentucky bluegrass-mixed forbs	2.25			
13560	1978-1979	Catherine Creek	Grazed	Mammals	S		Kentucky bluegrass-mixed forbs	2.25	N		
13560	1978-1979	Catherine Creek	Ungrazed	Mammals	S		Douglas Hawthorne-kentucky bluegrass	3.00			
13560	1978-1979	Catherine Creek	Grazed	Mammals	S		Douglas Hawthorne-kentucky bluegrass	1.67	Y	E	
13560	1978-1979	Catherine Creek	Ungrazed	Mammals	S		Black cottonwood-mixed conifer	3.33			
13560	1978-1979	Catherine Creek	Grazed	Mammals	S		Black cottonwood-mixed conifer	2.67	N	E	
13559	1977	Medicine Lodge	Ungrazed	Mammals	S		Small Mammals	42.60			
13559	1977	Medicine Lodge	Grazed	Mammals	S		Small Mammals	36.90	N	E	
13559	1974	Big Hole Mtns	Ungrazed	Mammals	S		Small Mammals	8.00			
13559	1974	Big Hole Mtns	Grazed	Mammals	S		Small Mammals	10.00	N	O	
13570	1985	Rio de las Vacas	Ungrazed	Reptiles	Number		Snakes	144.50			

Ref#	Year	Site	Treatment	Variable	Measure	Units	Species or subcategory	Result	Stat Sig?	1.5x?	E/O
13570	1985	Rio de las Vacas	Grazed	Reptiles	Number		Snakes	15.00		Y	E
13562	1964-1968	Rock Creek	Ungrazed	Soils	Organic Matter	%	0-40 cm	6.20		Y	E
13562	1964-1968	Rock Creek	Grazed	Soils	Organic Matter	%	0-40 cm	0.64		Y	E
13562	1964-1968	Rock Creek	Ungrazed	Soils	Phosphorus	mg/l	0-40 cm	4.50		Y	E
13562	1964-1968	Rock Creek	Grazed	Soils	Phosphorus	mg/l	0-40 cm	2.06		Y	E
13061	1981-1983	Empire Creek	Ungrazed	Veg	Biomass	kg/ha		5835.00		Y	E
13061	1981-1983	Empire Creek	Grazed	Veg	Biomass	kg/ha		3861.00		Y	E
13570	1985-1986	Rio de las Vacas	Ungrazed	Veg	Cover	rel. %	Herbaeconous plants	54.50			
13570	1985-1986	Rio de las Vacas	Grazed	Veg	Cover	rel. %	Herbaeconous plants	65.60		N	O
13564		Bitterroot River	Ungrazed	Veg	Cover	%	Canopy	29.20			
13564		Bitterroot River	Grazed	Veg	Cover	%	Canopy	34.70		N	O
13570	1985-1986	Rio de las Vacas	Ungrazed	Veg	Density	#/250 sq m	All trees	8.50			
13570	1985-1986	Rio de las Vacas	Grazed	Veg	Density	#/250 sq m	All trees	0.30		Y	E
13570	1985-1986	Rio de las Vacas	Ungrazed	Veg	Density	#/250 sq m	All shrubs	6.70			
13570	1985-1986	Rio de las Vacas	Grazed	Veg	Density	#/250 sq m	All shrubs	0.20		Y	E
13062	1975-1983	Meadow Creek	Ungrazed	Veg	Density	lbs/acre	Grasses	1294.00			
13062	1975-1983	Meadow Creek	Grazed	Veg	Density	lbs/acre	Grasses	1525.00		Y	O
13062	1975-1983	Meadow Creek	Ungrazed	Veg	Density	lbs/acre	Forbs	186.00			
13062	1975-1983	Meadow Creek	Grazed	Veg	Density	lbs/acre	Forbs	362.00		Y	O
13562	1964-1968	Rock Creek	Ungrazed	Veg	Density		Cottonwoods > 1 m	2.40			
13562	1964-1968	Rock Creek	Grazed	Veg	Density		Cottonwoods > 1 m	1.60		Y	E
13562	1964-1968	Rock Creek	Ungrazed	Veg	Density		Tall Shrubs > 1 m	5.70			
13562	1964-1968	Rock Creek	Grazed	Veg	Density		Tall Shrubs > 1 m	0.70		Y	E
13562	1964-1968	Rock Creek	Ungrazed	Veg	Density		Low Shrubs < 1 m	24.50			
13562	1964-1968	Rock Creek	Grazed	Veg	Density		Low Shrubs < 1 m	1.90		Y	E
13667	1960-1978	South Platte	Ungrazed	Veg	Density	#/ac	All Trees	50.80			
13667	1960-1978	South Platte	Grazed	Veg	Density	#/ac	All Trees	42.90		N	E
13667	1960-1978	South Platte	Ungrazed	Veg	Density	#/ac	Cottonwood	40.30			
13667	1960-1978	South Platte	Grazed	Veg	Density	#/ac	Cottonwood	28.80		N	E
13667	1960-1978	South Platte	Ungrazed	Veg	Density	#/ac	Willow	10.50			
13667	1960-1978	South Platte	Grazed	Veg	Density	#/ac	Willow	14.20		N	O
13552	1965-1967	South Dakota	Ungrazed	Veg	H'			2.86			
13552	1965-1967	South Dakota	Grazed	Veg	H'			3.63		N	O
13089	1976	Elk City, Idaho	Ungrazed	Veg	H'		Moist	2.73			
13089	1976	Elk City, Idaho	Grazed	Veg	H'		Moist	2.46		N	E

Ref#	Year	Site	Treatment	Variable	Measure	Units	Species or subcategory	Result	Stat Sig?	1.5x?	E/O
13089	1976	Elk City, Idaho	Ungrazed	Veg	H'		Wet	1.10			
13089	1976	Elk City, Idaho	Grazed	Veg	H'		Wet	1.83		Y	O
13569	1978	Gunnison	Ungrazed	Veg	H'			1.92			
13569	1978	Gunnison	Grazed	Veg	H'			3.13		N	O
12846	1988-1989	Sheep Creek	Ungrazed	Veg	H'			3.24			
12846	1988-1989	Sheep Creek	Grazed	Veg	H'			2.72		N	E
13089	1976	Elk City, Idaho	Ungrazed	Veg	S			19.00			
13089	1976	Elk City, Idaho	Grazed	Veg	S			15.00		N	E
13089	1976	Elk City, Idaho	Ungrazed	Veg	S			5.00			
13089	1976	Elk City, Idaho	Grazed	Veg	S			9.00		Y	O
13552	1965-1967	South Dakota	Ungrazed	Veg	S			27.00			
13552	1965-1967	South Dakota	Grazed	Veg	S			26.25		N	E
12846	1988-1989	Sheep Creek	Ungrazed	Veg	S			55.33		N	E
12846	1988-1989	Sheep Creek	Grazed	Veg	S			50.00		N	E
13552	1965-1967	South Dakota	Ungrazed	Veg	S			27.00			
13552	1965-1967	South Dakota	Grazed	Veg	S			26.25		N	E
13564		Bitterroot River	Ungrazed	Veg	Volume	%	Ground cover	11.90			
13564		Bitterroot River	Grazed	Veg	Volume	%	Ground cover	7.00		N	Y
13564		Bitterroot River	Ungrazed	Veg	Volume	%	Bush cover	36.50			
13564		Bitterroot River	Grazed	Veg	Volume	%	Bush cover	13.60		Y	Y
13564		Bitterroot River	Ungrazed	Veg	Volume	%	Mid-canopy	29.10			
13564		Bitterroot River	Grazed	Veg	Volume	%	Mid-canopy	33.90		N	N
13564		Bitterroot River	Ungrazed	Veg	Volume	%	Canopy	22.60			O
13564		Bitterroot River	Grazed	Veg	Volume	%	Canopy	45.20		Y	Y
13663	1975	Big Creek	Ungrazed	Water	Nitrate	mg/l	Nitrate as N	0.30			
13663	1975	Big Creek	Grazed	Water	Nitrate	mg/l	Nitrate as N	0.30		N	

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